ESTIMATION OF STRIPED HYENA *HYAENA HYAENA* POPULATION USING CAMERA TRAPS IN SARISKA TIGER RESERVE, RAJASTHAN, INDIA

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We used camera trap based capture-recapture method to estimate the population size of Striped Hyena *Hyaena hyaena* in Sariska Tiger Reserve. Twenty-five days of camera trapping was done with a sampling effort of 1,675 trap nights from January to April 2008. Camera traps yielded a total of 85 Hyena photographs of 26 individuals within an effective trapping area of 229.7 sq. km. Heterogeneous Jacknife model was best fit in estimating population with a capture probability of 0.31 P(hat). Population size was 34 ±(SE 5.4) and density was estimated as 15.1 ±6.2 hyena/100 sq. km (spatially explicit model). The study revealed that camera based capture-recapture method is an effective tool for assessing the population size of Striped Hyena in Sariska.

Key words: Camera trapping, *Hyaena hyaena*, individual identification, Sariska Tiger Reserve

INTRODUCTION

The Striped Hyena *Hyaena hyaena* is one of the most important large scavengers; its role in clearing off carrion in tropical ecosystems and in recycling mineral compounds from dead organic matter enhances its biological importance (Kruuk 1976). They generally prefer arid to semi-arid environment and avoid open desert and dense thickets (Prater 1971; Kruuk 1976; Leakey *et al.* 1999). The current distribution range of this species extends from East to North-east Africa, through the Middle East, Caucasus region, Central Asia and into the Indian subcontinent (Mills and Hofer 1998). In the Indian subcontinent, they occur in arid and semi-arid ecosystems, as well as in the extremely wet regions of south-western coast (Prater 1971; Karanth 1986). According to Mills and Hofer (1998), the estimated population of Striped Hyena in India was *c.* 1,000, which was a gross under-estimate. The camera trap based capture-recapture framework to estimate population of large carnivores, based on natural markings on their bodies, has proven to be amongst the most successful non-invasive method for species such as Tiger *Panthera tigris* (Karanth and Nichols 1998; Karanth *et. al.* 2004; Contractor 2008; Sharma *et al.* 2009), Leopard *Panthera pardus* (Chauhan *et al.* 2005; Edgoankar *et al.* 2007; Harihar *et al.* 2009), Jaguar *P. onca* (Silver *et al.* 2004), Geoffrey's Cat *Oncifelas geoffroyi* (Cuéller *et al.* 2006), Snow Leopard *Uncia uncia* (Jackson *et al.* 2006) and Striped Hyena (Singh 2008). This technique takes advantage of distinctive individual markings through photographs for even heavily furred animals such as Ocelot *Leopardus pardalis* (Trolle and Kery 2003), Wolf *Chrysocyon brachyurus* (Trolle *et al.* 2007), and Puma *Puma concolor* (Kelly *et al.* 2008). The individual identification in Spotted Hyena has been done earlier using pelage and nicks in ears (Holekamp and Smale 1990; Hofer and East 1993). The present study was aimed to estimate the population of Striped Hyena on the basis of spatially explicit closed capture models in a semi-arid landscape and to standardize the camera trapping method.

MATERIAL AND METHODS

Study area

The study was conducted in Sariska Tiger Reserve (Sariska TR), (25°5'-27°33' N; 74°17'-76°34' E), which is situated in the Aravalli Hill Range and lies in the semi-arid part of Rajasthan (Rodgers and Panwar 1988). The total area of the Tiger Reserve is 881 sq. km, with 273.8 sq. km as a notified National Park. The vegetation of Sariska corresponds to Tropical dry deciduous and Northern Tropical thorn forests (Champion and Seth 1968). The Park supports various carnivore species such as Tiger, Leopard, Striped Hyena, Caracal *Caracal caracal*, Jackal *Canis aureus*, Jungle Cat *Felis chaus* and prey species like Chital *Axis axis*, Sambar *Rusa unicolor*, Nilgai *Boselaphus tragocanelus*, Common Langur *Semnopithecus entellus*, Wild Pig *Sus scrofa*, Porcupine *Hystrix indica*, Rufous-tailed Hare *Lepus nigricollis ruficaudatus* and Indian Peafowl *Pavo cristatus* (Sankar 1994). There are 32 villages within Sariska TR. A large number of buffaloes, goats, sheep and cattle are kept by people living in villages.

METHODS

A preliminary survey was carried out from November to December 2007 in the intensive study area of 80 sq. km in

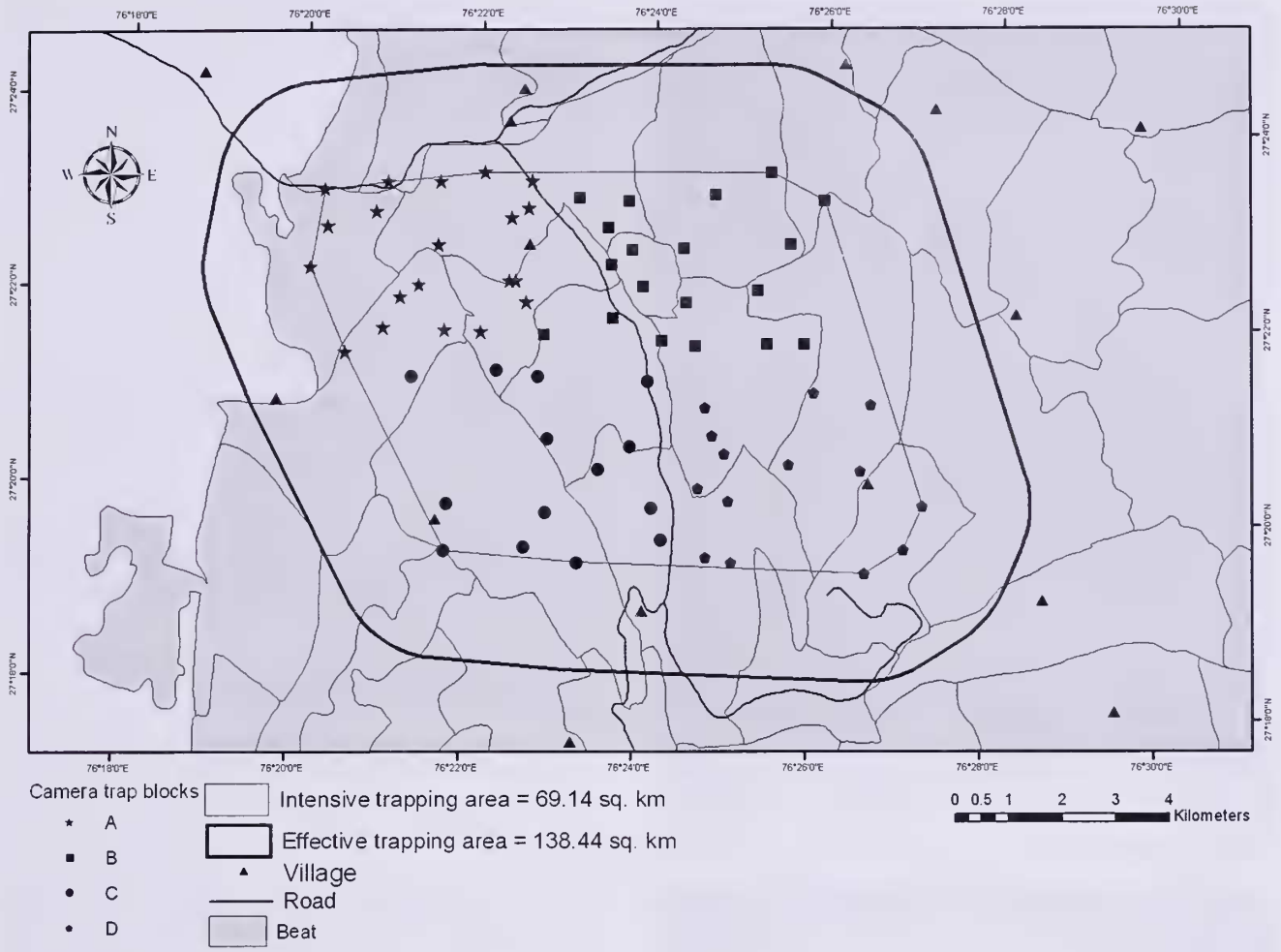

Fig. 1: Camera trap locations in intensive study area of Sariska Tiger Reserve (January to April 2008)

the National Park. Indirect signs such as spoor and scats of Hyena were identified and marked using a handheld Global Positioning System. Striped Hyena camera trapping data was collected from January to April 2008 in the intensive study area. We placed the camera in 1x1 sq. km grid. Camera traps were placed on the basis of hyena evidence (tracks, scats) on the trails. We used 20 units of analog cameras that worked on passive infrared motion/heat sensors. The camera traps were equipped with 35 mm lens which recorded the date and time of each photograph. The camera delay was kept at minimum (15 seconds) and sensor sensitivity was set at high. A total of 67 locations were selected for the placement of camera traps in the study area (Fig. 1). The study area was divided into four blocks of 20 sq. km each. Block A consisted of 20 camera trap sites, block B had 19, C and D blocks had 14 camera trap sites each. The mean inter trap distance was 726 m (ranging from 700 to 1,200 m). Camera traps were operated for 25 consecutive occasions with the total sampling period of 100 days (1,675 trap nights). Individual Hyena obtained from camera trap photographs were identified by a combination of distinguishing characters such as position and shape of stripes on flanks, limbs and forequarter, pattern and spots on flanks (Schaller 1967; Karanth 1995; Singh 2008) (Fig. 2). Any photograph with distorted perspective, or which lacked clarity, was discarded (n=8). Every Hyena captured was given a unique identification code like H1, H2, H3, etc. Capture history of each individual was generated in an X matrix format (Otis *et al.* 1978). Each day-wise sampling occasion was constructed for example by taking 1st day from block A, B, C and D as day one for entire study area and all subsequent days were combined in this manner to construct a matrix of capture for study area (Karanth 1995). Estimation of population size using closed capture models requires the population under investigation to be both demographically and geographically closed. We tested for population closure using software CAPTURE (Otis *et al.* 1978; Rexstad and Burnham 1991). The density (D) of Hyena in the study area was estimated by spatially explicit model (Efford 2004; Sharma *et al.* 2009) using Density 4.1 software (Efford 2004). The density of Striped Hyena was calculated by four different

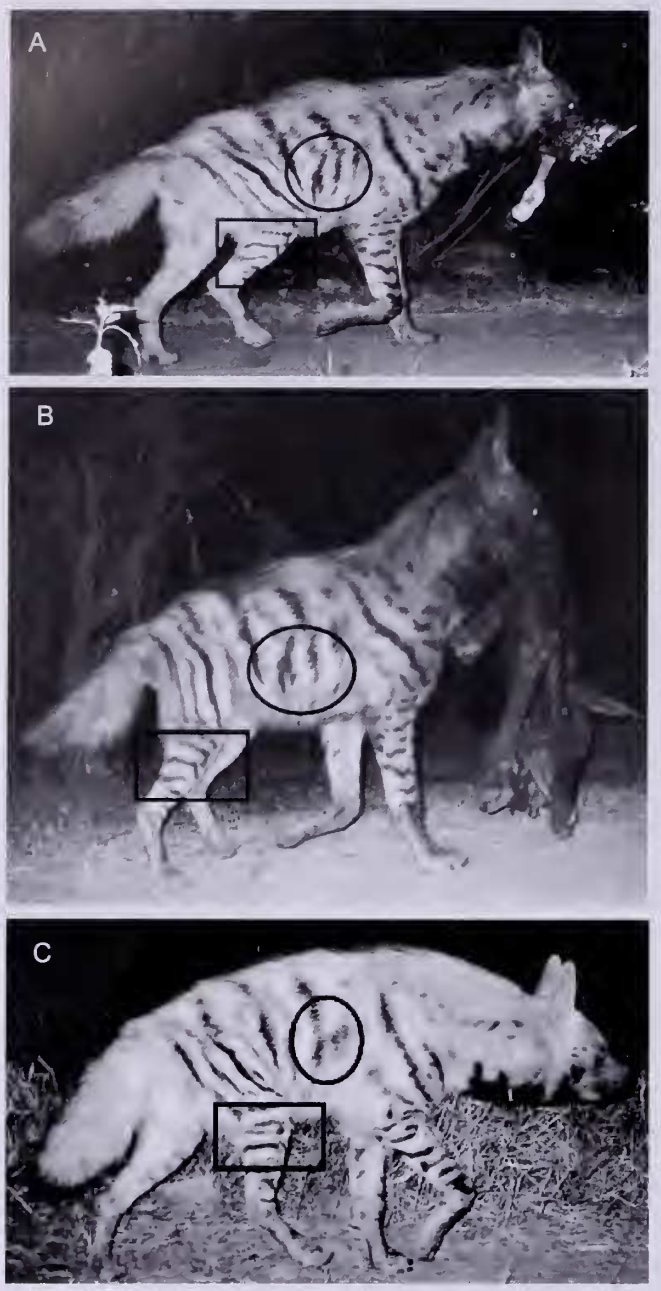

Fig. 2: Two individual hyenas captured by camera trap (A) and (B) show individual H4 with stripes and spots on flanks identical in shape and pattern. While (C) shows a different individual H10 with stripes and spots on flanks being clearly different in shape and pattern

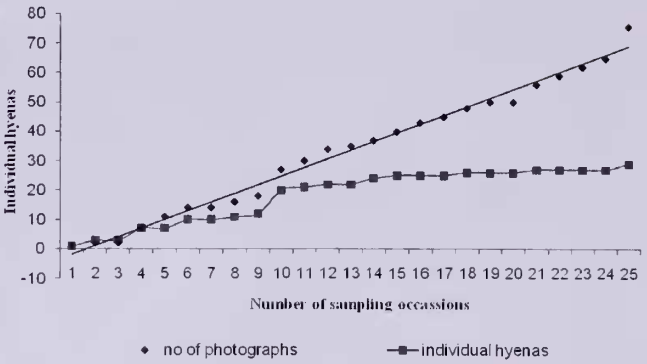

Fig. 3: Number of Striped Hyena photographed and number of hyena photographs with increasing number of sampling occasions to evaluate trap shyness and sampling adequacy in intensive study area

methods such as full mean maximum density moved (MMDM), half MMDM, spatially explicit Inverse Prediction density (IP dens) and spatial Maximum Likehood density (ML dens) (Sharma *et al.* 2009).

RESULTS

The intensive trapping resulted in a total of 85 photographs of 26 individual hyenas, based on right flank profile, as the number of individuals identified from the right flank was maximum. The 67 trapping stations covered an effective trapping area (ETA) of 229.7 sq. km (Full MMDM) and the number of new individuals was found to stabilize after the 19th trap night (Fig. 3). Population was closed for the sample period (z = -0.49, P=0.31) (Otis *et al.* 1978). The overall model selection test based on discriminant functions using the model selection algorithm of CAPTURE identified Mh as the most appropriate model in our study. The model selection scores are as follows: M (h) = 1.00, M (tb) = 0.99, M (o) = 0.96, M (b) = 0.82, M (tbh) = 0.78, M (bh) = 0.68, M (th) = 0.42, and M (t) = 0.00. The estimated Hyena population size (N) was = 34± SE (5.4) (Table 1). Density (D) and flank data using spatial explicit model was 15.1 individual/100 sq. km. MMDM and effective trapping area (ETA) was calculated by different methods using the program DENSITY 4.4 (Table 1). Half normal detection function fitted the best and

Table 1: Density estimates of Sriped Hyena in Sariska Tiger Reserve (January to April 2008)

Model	N	SE(N)	P (hat)	Methods for Calculating ETA	Width (km)	ETA (sq. km)	D (hyenas/ 100 sq. km)	SE
Mh (Jackknife)	34	5.4	0.31	MMDM/2	1.832	138.9	24.5	4.3
				MMDM	3.663	229.7	14.9	3.0
				IP DENS	-	-	15.1	6.2
				ML DENS	-	-	12.7	2.8

(N= Population estimate, P (hat)=capture probability, Width=Buffer strip width, ETA=effectively trapped area, D=Density estimate, MMDM=mean maximum distance moved, IP Dens=Inverse Prediction density, ML Dens= Maximum Likelihood density, SE = Standard error)

the density arrived from right half MMDM densities were 24.5 individual/ 100 sq. km and 14.9 individual/ 100 sq. km respectively. Spatial density and full MMDM yielded almost similar results.

DISCUSSION

The capture-recapture technique based on camera trap photographs of Hyena provided a statistically robust estimate in estimating the population. We had also corroborated hyena tracks and photographs at camera location for trap shyness response and did not observe any behavioural response during the study period. Effort required in terms of sampling occasions suggested that a minimum of 20 days are required to get reliable density estimates for hyena in the study area. Out of 85 captures, 12 individual Hyena were recaptured more than three times, 4 individuals were captured twice and 10 individuals had single captures. Some traps showed very high capture rates (2 to 20 captures/trap location), while individual captures/trap ranged from 1 to 8 individuals/trap location. Camera traps deployed near villages Haripura and Kiraska showed high individual capture rates such as 11% (n=7) and 14% (n=9) respectively. This may be attributed to availability of carcasses (livestock) in and around these villages on which hyenas might be scavenging. The estimated Hyena density in Sariska TR is the highest as compared to available studies in India and Africa (Kruuk 1976; Wagner 2006; Singh 2008; Wagner *et al.* 2008) and this might be attributed to the availability of high wild prey base and domestic livestock, i.e., of 105 animal/sq. km and 222 animals/ sq. km respectively (Avinandan *et al.* 2008; Sankar *et al.* 2009). Spatially explicit models and full MMDM give reliable estimates of density (Sharma *et al.* 2009) and we chose these estimates for density estimation. The camera trap based capture-recapture method is proven to be good to estimate Hyena abundance and can be reliably used in various habitat types.

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